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Original research

Predictors of in-hospital mortality amongst octogenarians undergoing emergency general surgery: A retrospective cohort study

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HIGHLIGHTS

- Emergency general surgery in octogenarians is generally high risk.
- Patients should be judged on physiological fitness for surgery rather than by age.
- COPD & increasing ASA score are significant & independent predictors of mortality.

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ABSTRACT

Introduction: Elderly patients are often judged to be fit for emergency surgery based on age alone. This study identified risk factors predictive of in-hospital mortality amongst octogenarians undergoing emergency general surgery. **Methods**: A retrospective review of octogenarians undergoing emergency general surgery over 3 years was performed. Parametric survival analysis using Cox multivariate regression model was used to identify risk factors predictive of in-hospital mortality. Hazard ratios (HR) and corresponding 95% confidence interval were calculated. **Results**: Seventy-three patients with a median age of 84 years were identified. Twenty-eight (38%) patients died post-operatively. Multivariate analysis identified ASA grade (ASA 5 HR 23.4 95% CI 2.38–230, $p = 0.007$) and chronic obstructive pulmonary disease (COPD) (HR 3.35 95% CI 1.15–9.69, $p = 0.026$) to be the only significant predictors of in-hospital mortality. **Conclusions**: Identification of high risk surgical patients should be based on physiological fitness for surgery rather than chronological age.

1. Introduction

Many countries around the world have an ageing population that is rapidly expanding. There are at least 2.6 million people aged 80 years and over in England and Wales and this number is expected to double in the next 25 years [1]. As life expectancy is increasing the surgeon will encounter an ever increasing number of elderly patients with surgical problems. The increase in this surgical caseload will be observed both for elective and emergency work but as elderly patients are more likely to be admitted for emergency surgery it is likely that this will have the largest impact in the acute setting [2].

As people get older they are more likely to have increasing co morbidities. Multiple studies have shown that the primary pre-operative risk factor for poor surgical outcome in the elderly is co-morbidity rather than chronological age [3]. Although the rate of surgical complications in older patients is comparable with that of younger patients, their rate of medical complications is higher [4]. Chronic cardiac and respiratory disease and functional reserve of the patient are consistently implicated [3]. The occurrence of post-operative complication has been shown to be more important than pre operative and intra operative risk factors in determining post-operative survival [5]. Predictably emergency surgery in the elderly carries a much higher mortality rate [6].

The goal in emergency surgery in an ageing population is to objectively assess a patient by their physiological age and co-existing co morbidities rather than by their chronological age. Unlike elective surgery there is great variation of pathology and a very limited time period in which to optimize existing co morbidities. The emergent nature of surgery also limits access to investigations that stratify risk of surgery, such as cardio-pulmonary exercise testing (CPEX) and metabolic equivalents (MET) [7,8]. The challenge for the emergency surgeon is to be able to quickly and

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reliably identify individuals prior to surgery who are high risk so that appropriate arrangements for perioperative critical care and post-operative support can be planned.

There are established care pathways for treatment of elderly patients with fractured neck of femur to try and improve prognosis and outcome. Similarly high risk patients admitted for elective general surgical procedures have enhanced recovery pathways and models such as Proactive care of Older People undergoing Surgery (POPS) in place to provide them with an extensive package of perioperative care and appropriate discharge planning [9]. Although emergency laparotomy is the second most common operation undertaken after femoral neck fractures in this population, there are currently not the same infra structures in place to provide similar standards of peri- and post-operative care.

The aims of our paper were to identify risk factors that predict in-hospital morbidity and mortality amongst octogenarians undergoing emergency general surgery. We hoped that this would give us a better understanding of prognosis and enable us to make informed decisions with the patient and their relatives about best emergency treatment.

2. Methods

We undertook a retrospective notes review of all patients aged 80 years of age or over who underwent an emergency laparotomy at Medway Maritime Hospital between July 2008 and June 2011. Vascular surgery procedures were excluded. Patients were identified using Crystal Reports. Patient demographics including age, gender and medical co-morbidities were documented. The co-morbidities analysed included a prior diagnosis of ischaemic heart disease (IHD), diabetes mellitus (DM), cerebrovascular accident (CVA), chronic obstructive pulmonary disease (COPD) and any cancer. Regular medications (including steroid use and anti-coagulation with warfarin), pre-morbid functional status (as determined by the American Society of Anaesthesia (ASA) grade on presentation) and time of surgery were recorded. Time from decision to operate to surgery and post-operative intensive care unit (ICU) admission were also noted.

Post-operative morbidity and in-hospital mortality data were collected, including return to theatre and re-admission within 30 days of surgery. Any respiratory, cardiac, infectious, renal, neurological and bleeding complications were recorded. Cause(s) of death, both as an inpatient and within 12 months of laparotomy were documented.

Statistical analysis was conducted using Stata© SE 10.1 for Macintosh (StataCorp, College Station, Texas, USA). Continuous data are presented as median value and range. Kaplan–Meier life-table analysis was used to calculate the cumulative incidence of in-hospital mortality following unplanned laparotomy. Univariate survival analysis based on the Cox proportional hazards regression methodology was applied to identify individual risk factors predictive of in-hospital mortality. Variables with a univariate p value less than 0.25 were evaluated by multivariate analysis. Hazard ratios (HR) and corresponding 95% confidence intervals were calculated for each variable. Relative risk was calculated and proportions compared using Mann–Whitney U-test. All statistical tests performed were two-sided with significance assumed at p less than 0.05.

3. Results

3.1. Patient demographics

A total of 73 patients (50 females) with median age of 84 (80–98) years underwent an emergency laparotomy over the study period. Table 1 lists the demographics of this group and the procedure performed at laparotomy.

3.2. Morbidity and mortality

Over a median length of stay of 23 (2–71) days there were 28 (38%) in-hospital mortalities. Of the in-hospital mortalities 5 patients had an ASA grade of 2, 13 had an ASA grade of 3, 7 had an ASA grade of 4 and 3 were ASA score 5 (Table 2). Fifty-one (70%) patients had one or more documented post-operative complication. The majority of complications were respiratory, cardiac, renal or infective (including wound infection). The causes of mortality and post-operative morbidities are shown in Table 1. Post-operative morbidity was observed in 24 of the 28 patients who died within 30 days of surgery. Patients who developed any post-operative morbidity were three times more likely to undergo subsequent in-hospital mortality (risk ratio 2.8 95% CI 1.06–7.43, $p = 0.021$) (Table 3).

3.3. Cox analysis of variables predicting in-hospital mortality following emergency laparotomy

Multivariate analysis identified ASA grade (ASA 5 HR 23.4 95% CI 2.38–230, $p = 0.007$) and COPD (HR 3.35 95% CI 1.15–9.69, $p = 0.026$) to be the only significant and independent predictors of in-hospital mortality (Table 4). Prior CVA, AF, COPD, functional status, and post-operative ICU stay and return to theatre, were predictive of mortality in univariate analysis only Figs. 1 and 2 show the influence of ASA grade and diagnosis of COPD on in-hospital mortality rate.

4. Discussion

Emergency laparotomy in elderly patients is high risk. Studies report mortality rates of 24%–38% and morbidity rates of 24%–64% [6,10,11]. These figures have remained largely unchanged over several decades. Despite advances in surgical and perioperative care, little seems to have improved the prognosis of the elderly patient undergoing emergency laparotomy.

Table 1
Patient demographics, post-operative morbidity and in-hospital mortality within 30 days.

Number of patients	73
Median (range) age (years)	84 (80–98)
Male:Female	23:50
Median (range) number of medications	5 (0–11)
Type of surgery performed:	
Small bowel obstruction	18 (25%)
Colonic surgery	25 (35%)
Peptic ulcer repair	5 (7%)
Surgery for hernia	6 (8%)
Other(s)	19 (26%)
Post-operative morbidity	**Number of patients (%)**
Respiratory complications	30 (40%)
Cardiac complications	23 (30%)
Infective complications	24 (32%)
Renal impairment	22 (30%)
Post-operative confusion	6 (8%)
Neurological complications	3 (4%)
Return to theatre within 30 days	7 (10%)
Readmission within 30 days of discharge	7 (10%)
In-hospital mortality/cause of death	
Bowel ischaemia	7 (25%)
Multiorgan failure/sepsis	7 (25%)
Metastatic disease	4 (14%)
Others (MI, PE, aspiration)	6 (22%)
Unknown	4 (14%)

Table 2
Relationship between ASA score and in-hospital mortality.

ASA grade	In-hospital mortality		Total (Percentage)
	Yes	No	
2	5	16	21 (23.8)
3	13	17	30 (43.3)
4	7	12	19 (36.8)
5	3	0	3 (100.0)

Unlike elective surgery, many risk factors cannot be modified prior to a patient undergoing emergency surgery. Although co-morbidity and underlying pathology cannot be altered, prompt assessment and diagnosis, appropriate pre operative resuscitation and timely access to theatre and post-operative critical care can have benefits [12,13]. Limiting physiological disturbance intra operatively by applying principles of damage limitation surgery and the use of goal directed fluid therapy also improves outcomes. There is already much evidence in elective surgery to support the use of intra operative monitoring to optimize cardiac output and tissue perfusion and the use of goal directed fluid therapy is becoming more widespread in the emergency setting [14,15]. Although we have no numbers from this data set our unit uses intra operative Doppler monitoring for the majority of emergency laparotomies.

Our data has shown that the risk of in-hospital mortality is significantly greater in those individuals with higher ASA scores and in the presence of COPD. Patient age and type of operation performed, which are commonly taken into account were not found to be predictive of poor outcome.

We found that high ASA scores are an independent and significant risk factor for mortality in emergency laparotomy in the elderly, which is consistent with other studies [10–12]. ASA scoring has been criticized for being too subjective and simplistic as it is extrapolated from history and examination findings only, but it can be easily and quickly calculated at the bedside [16]. More comprehensive scoring systems such as APACHE II or P-POSSUM have all been shown to predict mortality in emergency general surgical patients and have even been modified for the elderly (Elderly-POSSUM) [17]. However these do require operative findings for a complete score. Therefore, ASA may be a useful tool prior to surgery and may assist us as surgeons when discussing management and prognosis with patients and relatives.

The presence of COPD in our study population was also identified as a significant and independent predictor of in-hospital mortality. This is predictable as both general anaesthesia and abdominal surgery have a negative effect on respiratory function [18]. In the emergency setting there is often not the time nor is it always possible to pre-optimise respiratory function and avoid large incisions in patients with COPD. However, there is evidence to show that it is possible to reduce pulmonary complications through lung expansion therapies, such as incentive spirometry, deep breathing exercises and continuous positive pressure airway pressure in the post-operative period. Timely referral and interaction

Table 3
Relationship between post-operative morbidity and mortality.

Post-op morbidity	In-hospital mortality		Risk ratio (95% CI *p*-value)
	No	Yes	
No	18	4	2.8 (1.06–7.43, $p = 0.021$)[a]
Yes	27	24	

[a] Mann–Whitney *U*-test.

Table 4
Univariate analysis of risk factors predictive of in-hospital mortality following emergency laparotomy.

Risk factor	Number	HR	95% CI	*p*-value
Gender				
Male	50 (68%)	1		
Female	23 (32%)	1.04	0.43–2.49	0.923
IHD				
No	48 (65%)	1		
Yes	25 (35%)	0.76	0.34–1.69	0.498
CVA				
No	61 (83%)	1		
Yes	12 (17%)	2.70	1.14–6.48	0.024
AF				
No	53 (73%)	1		
Yes	20 (27%)	0.31	0.11–0.95	0.039
COPD				
No	61 (84%)	1		
Yes	12 (16%)	2.10	0.87–5.10	0.099
Diabetes				
No	63 (87%)	1		
Yes	10 (13%)	1.04	0.39–2.83	0.931
Hypertension				
No	20 (27%)	1		
Yes	53 (73%)	1.69	0.58–4.93	0.341
Cancer				
No	53 (73%)	1		
Yes	20 (27%)	0.86	0.32–2.30	0.769
Steroids				
No	67 (92%)	1		
Yes	6 (8%)	0.93	0.27–3.21	0.909
Anticoagulants				
No	63 (87%)	1		
Yes	10 (13%)	0.67	0.16–2.84	0.587
Functional status				
Independent	55 (75%)	1		
Carer-dependant	12 (16%)	1.43	0.47–4.34	0.53
NH/bed-bound	6 (9%)	3.26	1.16–9.20	0.025
ASA grade				
2	21 (29%)	1		
3	30 (41%)	2.74	0.89–8.43	0.079
4	19 (26%)	2.43	0.70–8.42	0.162
5	3 (4%)	15.4	3.28–71.8	0.001
Post-op ICU care				
No	44 (60%)	1		
Yes	29 (40%)	2.50	1.16–5.41	0.020
Post-op HDU care				
No	25 (35%)	1		
Yes	48 (65%)	0.62	0.29–1.33	0.221
Operation within 12 h				
No	28 (40%)	1		
Yes	45 (60%)	0.91	0.41–2.03	0.819

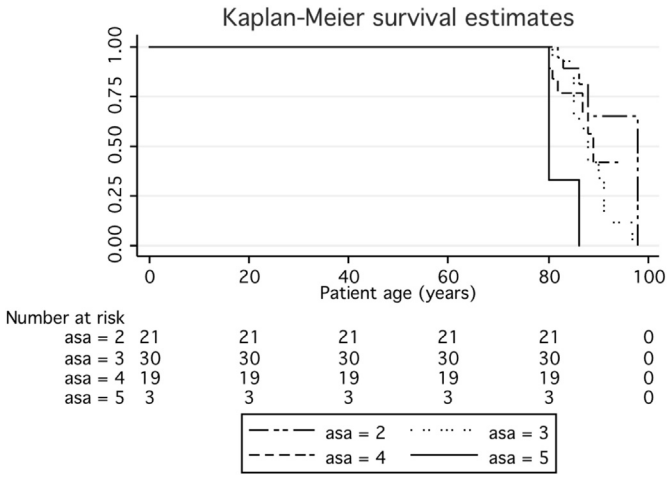

Fig. 1. In-hospital mortality following emergency laparotomy stratified by ASA grade.

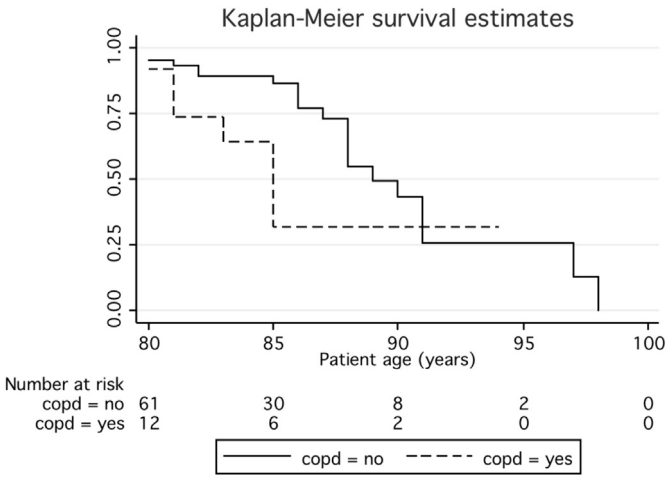

Fig. 2. In-hospital mortality following emergency laparotomy stratified by diagnosis of COPD.

with anaesthetists and chest physiotherapists could help reduce the mortality and morbidity of elderly general surgical patients with COPD.

Elderly patients have a higher rate of medical complications post surgery. This results in longer length of stay [19]. Analysis of morbidity and mortality rates to measure outcome provide objective data. Increased frailty (reduction in physiological reserve across multiple systems) and loss of independence are rarely considered by surgeons but equally as important. These may necessitate a significant change in lifestyle following surgery and can have profound effects on discharge planning and subsequent quality of life.

In elective patients, models of care such as POPS allow pre operative multidisciplinary assessment and optimization of co morbidities and formal risk prediction including likely post-operative complications. A peri-operative care plan is formulated which includes suggested management of post-operative complications if they occur and prediction of post-operative rehabilitation needs and discharge planning [4,9]. Similar pathways in emergency surgery patients have shown reduced post-operative complications and length of stay [9]. We already have similar pathways for elective and emergency orthopaedic patients at our hospital. Our vision would be to extend this to elective and emergency general surgical patients in the future.

There continues to be paucity of outcome data concerning emergency laparotomy. The Emergency Laparotomy Network (www.networks.nhs.uk/laparotomy) was established in January 2010 with the aim of gathering data and improving service and care to patients. Its membership currently represents approximately 25% of UK hospitals involved in emergency general surgery. By analysing data from a multicentre audit and facilitating reflective practice it is hoped to improve the outcome of patients undergoing emergency laparotomy.

Although this study reflects the practice in one district general hospital the high mortality and morbidity of octogenarians undergoing emergency abdominal surgery is a widespread problem. This paper has highlighted that improvements can be made through risk scoring, critical care and comprehensive geriatric management in order to identify and target resources at high risk individuals. Standards of care have been published by the Royal College of Surgeons for surgery in the elderly [20]. These, coupled with data from networks, should be used to drive service improvement and improve outcome for elderly patients undergoing emergency laparotomy.

5. Conclusion

This study demonstrates that emergency laparotomy in patients older than 80 years of age is high risk. This risk however, does not extend to all octogenarians as many elderly individuals may have safe, uneventful surgery. Identification of high risk surgical patients should be based on physiological fitness for surgery rather than chronological age. We suggest that the assessment of risk in the emergency situation should be based on ASA scoring and the presence of COPD, rather than the age of the patient, and the anticipated nature of the surgical intervention.

Ethical approval

None needed.

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None.

Author contribution

Iain Wilson – concept, data collection, presented, principal author.
Michael Barrett – study design, data collection, presented.
Ashih Sinha – concept, study design, statistics.
Shirley Chan – Concept, senior author.

Conflicts of interest

None.

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